CLAIMS

1. A multilayer ionizing radiation sensitive element including:

a substrate;

a conductive layer overlying said substrate;

an ionizing radiation sensitive layer overlying said conductive layer, operative to convert ionizing radiation impinging thereon to charge carriers; and

a blocking layer exposed to ionizing radiation and optical radiation, overlying said ionizing radiation sensitive layer, which generally limits the passage of charges, of at least one polarity, therethrough and blocks optical radiation, of at least one spectral band, from penetrating therethrough, while permitting passage therethrough of ionizing radiation.

2. A multilayer ionizing radiation sensitive element according to claim 1 and further comprising a charge buffer layer, disposed between said ionizing radiation sensitive layer and said conductive layer and which generally limits the passage of charges, of at least a second polarity, therethrough.

3. A multilayer ionizing radiation sensitive element according to claim 1 and wherein said ionizing radiation sensitive layer is a photoconductor formed of doped amorphous selenium.

4. A multilayer ionizing radiation sensitive element according to claim 3, in which the doped amorphous selenium is made of amorphous selenium doped with arsenic and chlorine.

5. A multilayer ionizing radiation sensitive element according to claim 3 and wherein the charge buffer layer is formed of amorphous arsenic triselenide.

6. A multilayer ionizing radiation sensitive element according to claim 3 and wherein the blocking layer is formed of alkali doped selenium.

7. A multilayer ionizing radiation sensitive element according to claim 1 and wherein said ionizing radiation sensitive layer is a photoconductor selected from the group consisting of a selenium alloy, lead iodide, lead oxide thallium bromide, cadmium telluride, cadmium zinc telluride, cadmium sulfide, and mercury iodide.

8. A multilayer ionizing radiation sensitive element according to claim 1 and wherein the blocking layer is formed of a dielectric polymer carrier loaded with selected pigments or dyes.

9. A multilayer ionizing radiation sensitive element according to claim 1 and further comprising an interstitial dielectric passivation layer disposed between the ionizing radiation sensitive layer and the blocking layer .

10. A multilayer ionizing radiation sensitive element according to claim 9 and wherein the interstitial dielectric passivation layer is formed of poly-para-xylylenes.

11. A multilayer ionizing radiation sensitive element according to claim 1 and wherein the conductive layer is patterned.

12. A multilayer ionizing radiation sensitive element according to claim 10 and wherein the patterned conductive layer is selected from the group consisting of indium tin oxide (ITO), aluminum, gold, platinum, and chromium.

13. A multilayer ionizing radiation sensitive element according to claim 1 and wherein said substrate is selected from the group consisting of glass, ceramic, and metal coated with a dielectric material.

14. A multilayer ionizing radiation sensitive element according to claim 1 and wherein said at least one spectral band of optical radiation includes photons having energy higher than a characteristic band gap energy of said ionizing radiation sensitive layer and wherein optical radiation having photon energy lower than said band gap energy of said ionizing radiation sensitive layer generally penetrates through said blocking layer.

15. A multilayer ionizing radiation sensitive element according to claim 1 and wherein said ionizing radiation sensitive layer is sensitive to X-ray radiation.

16. An elongate charge injection assembly including:

an elongate electrode embedded in a dielectric material;

an exposed screen electrode, separated from said embedded electrode by said dielectric material; and

at least one elongate dielectric wedge having an elongate metallized surface.

17. An elongate charge injection assembly according to claim 16 wherein the elongate charge injection assembly is operative to inject charge generally along the metallized surface of said elongate dielectric wedge.

18. An elongate charge injection assembly according to claim 17 wherein a floating AC voltage is applied between said elongate electrode and said exposed screen electrode and wherein the metallized surface of said dielectric wedge

and the exposed screen electrode are both biased to a DC potential relative to a ground reference.

19. An elongate charge injection assembly according to claim 18 and further including a substrate associated with said ground reference wherein the density and polarity of charge retained on said substrate following charge injection from said elongate charge injection assembly is generally determined by the value and polarity of said DC potential.

20. An elongate charge injection assembly according to claim 16 wherein said elongate electrode embedded in a dielectric material is a glass coated wire mounted on a dielectric rod.

21. An elongate charge injection assembly according to claim 20 wherein the exposed screen electrode is a conducting wire space-wound to form coils around said glass coated wire mounted on said dielectric rod.

22. An elongate charge injection assembly according to claim 20 wherein the dielectric rod and the dielectric wedge are formed of a dielectric material selected from the group including glass, alumina and other dielectric ceramics.

23. An elongate charge injection assembly according to claim 16 and further including a light source which is operative to project an elongate beam of optical radiation.

24. An elongate charge injection assembly according to claim 23 wherein said light source includes a plurality of light-emitting diodes and a plurality of resistors mounted on a rigid printed circuit board.

25. An elongate charge injection assembly according to claim 16 wherein said elongate charge injection assembly is a scanning assembly.

26. An ionizing radiation imaging module including:

a multilayer ionizing radiation sensitive element having at least one conductive layer and operative to convert an impinging ionizing radiation image to a charge distribution;

a charge injection assembly operative to inject charge into said multilayer ionizing radiation sensitive element; and

readout circuitry coupled to said conductive layer of said multilayer ionizing radiation sensitive element; and

wherein said charge injection assembly is operative to cause currents, corresponding to said charge distribution, to flow in said conductive layer providing a signal representation of said impinging ionizing radiation image.

27. An ionizing radiation imaging module according to claim 26 wherein the readout circuitry is removably coupled to said conductive layer.

28. An ionizing radiation imaging module according to claim 26 wherein said readout circuitry includes:

a plurality of multi-channel charge readout ASICs; and

a plurality of analog-to-digital converters coupled to said multi-channel charge readout ASICs.

29. An ionizing radiation imaging module according to claim 26 wherein the ionizing radiation is X-ray radiation.

30. An X-ray imaging module including:

an X-ray imaging element, operative to convert spatially modulated impinging X-ray radiation to a spatially modulated charge distribution wherein the amplitude of the spatially modulated charge distribution is generally dependent upon the intensity and duration of the exposure; and

an X-ray exposure sensor facing said X-ray imaging element and being operative to sense apparent surface voltages associated with said spatially modulated charge distribution in real-time during exposure in order to provide real-time X-ray exposure data.

31. An X-ray imaging module according to claim 30 wherein said X-ray exposure data is imagewise.

32. An X-ray imaging module according to claim 30 wherein said X-ray exposure sensor includes an X-ray permeable multilayer element having a first conducting layer facing said X-ray imaging element, a dielectric support layer, and real-time readout circuitry electrically coupled to said first conducting layer.

33. An X-ray imaging module according to claim 32 wherein said first conducting layer comprises a plurality of plate electrodes electrically coupled to said real-time readout circuitry.

34. An X-ray imaging module according to claim 33 wherein said X-ray permeable multilayer element further includes a conductive fanout layer electrostatically shielded from said X-ray imaging element and a second dielectric layer electrically insulating said conductive fanout layer from said first conducting layer.

35. An X-ray imaging module according to claim 30 and further including integrated data readout circuitry which is coupled to said X-ray imaging element and wherein said X-ray imaging module is operative to read out integrated X-ray radiation data corresponding to said spatially modulated charge distribution following X-ray exposure.

36. An X-ray imaging module according to claim 35 wherein real-time exposure data provided by said X-ray exposure sensor is used during integrated radiation data readout to enhance imaging.

37. An X-ray imaging module according to claim 30 and wherein real-time exposure data from said X-ray exposure sensor is used in real time to control a controllable X-ray source to terminate X-ray exposure.

38. A flat panel digital X-ray image detector including:

a casing having at least one X-ray permeable surface and enclosing:

a first conductive layer;

a second conductive layer ; and

an X-ray radiation sensitive element positioned between said first conductive layer and said second conductive layer; and

wherein said first conductive layer, said second conductive layer and said X-ray radiation sensitive element are operative to cause said X-ray radiation sensitive element to sense real-time exposure data from said first conductive layer and integrated radiation data from said second conductive layer, in response to impinging X-ray radiation.

39. A flat panel X-ray image detector according to claim 38 and also comprising real-time readout circuitry coupled to said first conductive layer and integrated data readout circuitry coupled to said second conductive layer.

40. A flat panel X-ray image detector according to claim 39 wherein the integrated radiation data is read out from said second conductive layer at a first spatial resolution and said real-time exposure data is read out from said first conductive layer at a second spatial resolution lower than said first resolution.

41. A flat panel X-ray image detector according to claim 38 wherein said first conductive layer and said X-ray radiation sensitive element are spaced from each other.

42. An ionizing radiation imaging module including:

an ionizing radiation sensor, operative to convert spatially modulated impinging ionizing radiation to a corresponding charge pattern;

a charge injector, operative in an environment of at least approximately atmospheric pressure to inject charge onto said ionizing radiation sensor, wherein the amount of charge injected onto said ionizing radiation sensor at a given location corresponds to the charge density at that location prior to charge injection.

43. An ionizing radiation imaging module according to claim 42 wherein operation of said charge injector causes measurable currents to flow in a conductive layer of said ionizing radiation sensor thereby providing a signal representation of said spatially modulated impinging ionizing radiation.

44. A flat panel digital X-ray image detector including:

a casing having at least one X-ray permeable surface and enclosing:

a generally planar X-ray sensitive element which is operative to retain a charge representation of spatially modulated X-ray imaging radiation impinging thereon; and

a scanner which is operative to mechanically scan over said X-ray sensitive element following exposure thereof to said spatially modulated X-ray imaging radiation in order to read out said charge representation to provide a digital representation of said spatially modulated X-ray imaging radiation.

45. A flat panel digital X-ray detector according to claim 44 wherein said scanner provides charge injection

46. An ionizing radiation image detector including:

an ionizing radiation sensitive element operative to convert an impinging ionizing radiation image to a digital signal representation thereof;

a source of optical radiation operative to project optical radiation onto said ionizing radiation sensitive element resulting in occupation of trap states without

generally causing photogeneration of free charge carriers in said ionizing radiation sensitive element;

and wherein said ionizing image radiation and said optical radiation impinge onto said ionizing radiation sensitive element from the same general direction.

47. A method for detecting ionizing radiation images including the following steps:

providing an ionizing radiation sensing multilayer element; a scanning charge injector which is capable of injecting positive and negative charges onto said multilayer element; and read circuitry coupled to said ionizing radiation sensing multilayer element;

sensitizing said ionizing radiation sensing multilayer element by creating a generally uniform charge distribution of a first value using the scanning charge injector;

exposing the sensitized ionizing radiation sensing multilayer element to ionizing radiation, thus causing charge redistribution over said ionizing radiation sensing multilayer element corresponding to the exposing ionizing radiation;

injecting charge into said ionizing radiation sensing multilayer element using said scanning charge injector, to create a generally uniform charge distribution of a second value wherein the amount of charge injected at each location of said ionizing radiation sensing multilayer element corresponds to the charge density at that location prior to charge injection and wherein currents, generally corresponding to the amount of injected charge, flow in said read circuitry; and

reading out said currents flowing in said read circuitry thereby providing a signal representation corresponding to the exposing ionizing radiation.

48. A method for detecting ionizing radiation images according to claim 47 wherein the second charge distribution value is selected so as to reduce a DC component associated with the spatial Fourier frequencies representing an ionizing radiation image in order to provide a tone scale remapping function.

49. A method for detecting ionizing radiation images according to claim 47 wherein the second charge distribution value is generally equal to the first charge distribution value thereby enabling the step of injecting charge to serve as the step of sensitizing the ionizing radiation sensing multilayer element.

50. A method for detecting ionizing radiation images according to claim 47 wherein the step of providing also includes the step of providing a scanning light source which projects an optical radiation beam onto said ionizing radiation sensing multilayer element and wherein the step of sensitizing said ionizing radiation sensing multilayer element includes the step of projecting an optical radiation beam resulting in the occupation of trap states within said ionizing radiation sensing multilayer element without directly photogenerating free charge carriers thereby reducing imaging ghost effects.

51. A method for detecting X-ray radiation exposure and including the steps of:

providing an X-ray radiation sensing multilayer element which is operative to convert an impinging radiation image to a corresponding apparent surface voltage pattern; and

sensing said apparent surface voltage pattern during exposure to provide X-ray radiation exposure data.

52. A method for detecting X-ray radiation exposure according to claim 51 wherein the provided X-ray radiation exposure data is imagewise.